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(12) # NEW EUROPEAN PATENT SPECIFICATION

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(54) **Apparatus for adjusting the timing of a fuel injection pump.**

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Description

The present invention relates to a fuel injection pump having a housing, said housing having a drainage passageway connected thereto and pressure relief valve means in said drainage passageway for normally maintaining a predetermined generally constant pressure in said pump housing, an inlet metering valve, a rotary charge pump having radially extending pumping plungers adapted to be actuated inwardly by a cam ring to deliver measured charges of liquid fuel in successive pumping strokes to the cylinders of an associated engine, timing means to vary the timing of the pumping strokes relative to the operation of the associated engine, and actuating means for actuating the timing means for advancing and retarding the timing of the pumping strokes in response to the operating conditions of the associated engine, said actuating means comprising a piston for actuating the timing means and having its ends exposed to fluid chambers at the opposite ends thereof, spring means engaging one end of the piston and said predetermined generally constant housing pressure in communication with one chamber at said one end of the piston biasing the piston in the direction to retard the timing, a source of fluid under pressure correlated with engine speed in communication with the other at the other end of the piston and acting against the bias of the spring and fluid pressure in said one to the timing with increased engine speed.

A fuel injection of the above type is known from US-A-3 704 963. The known pump is arranged to be driven by an associated engine at a speed correlated with the engine speed and is provided with pumping plungers for delivering measured charges of fuel at high pressures to the engine cylinders successively. The plungers are actuated in timed relationship to the operation of the engine by cam means which is made adjustable so that the moment of injection of each charge can be made to occur slightly earlier in relationship to the operation of the engine, in which case the timing is said to be "advanced" or to occur slightly later in which case the timing is said to be "retarded".

It has been generally accepted heretofore that a compression-ignition or Diesel-engine will tend to exhibit better performance characteristics and have increased efficiency if the timing of the fuel injections to the engine cylinder is retarded at low engine speed and advanced as speed increases. The above mentioned US-A-3 704 963 comprise a timing piston which on one side is exposed a speed dependent control pressure which increases with engine speed in order to provide the desired timing advance with increasing speed. The other side of the known timing piston is exposed a predetermined generally constant pressure and a spring operates in conjunction with the constant pressure to move the timing piston in a direction to retard injection timing.

While during normal running of the engine the above noted timing advance with increasing engine speed is desired, it has been found that there are exceptions when the engine is cold and is being started or driven at low speed. In those cases, the opposite is true and instead of being retarded, the timing of the fuel injection should be advanced for a good performance and to decrease emission of smoke and hydrocarbons.

From DE-A-2 638 736 a fuel injection pump is known wherein a speed dependent control pressure acts on one side of a timing control piston and a load dependent control pressure acts in conjunction with a spring on the other side of timing control piston. Also, means being provided to reduce the speed dependent control pressure in order to retard timing above a predetermined speed. This known device is disadvantageous because it interferes with the usual timing control under normal engine operating conditions.

Also, there have been many proposals heretofore, such as the controls described in US-A-4 122 813 and US-A-4 143 632 for advancing timing during cold starting but such controls have generally been complicated in design and expensive to fabricate and have frequently failed to operate effectively.

DE-A-2 648 043 is concerned with a fuel injection pump wherein injection timing is temporarily advanced when the engine is cold or operates at low speed. However, this known fuel injection pump does this by temporarily increasing the control pressure in the suction chamber of the pump by reducing during such conditions the amount of fuel recirculated to the fuel reservoir. This is undesirable since it also relies on changing the control pressure acting on the timing control piston.

US-A-3 439 624 teaches a system to control injection timing in response to the load and speed of the engine. The pressure in the spring chamber side of the timing piston changes with the load and is constantly in communication through a restriction with a pressurized interior drain space of the pump housing. Advancing the injection timing during cold start conditions is not contemplated in this US patent.

The object of the invention is to provide a fuel injection pump of the type described, a simple and effective means to advance the timing of the fuel injection pump during cold start and slow running of the associated engine without interfering with the operation of the usual timing control under normal engine operating conditions, and which is inexpensive to fabricate and install, is dependable in operation and will provide readily reproducible results from to pump.

In accordance with the invention, to solve this object, the fuel injection pump is characterized by pressure dump means selectively operable during cold starting or idling of the associated engine to connect said pump housing to drain for dumping the fluid pressure from said pump

housing and in said one chamber to the exterior of said pump housing and thereby advancing the timing by a predetermined amount.

In the subclaims additional preferred features of the fuel injection pump are claimed.

Embodiments of the fuel injection pump will now be described with reference to the drawings, wherein:

Fig. 1 is a partly schematic view of the timing adjustment apparatus, applied to an exemplary fuel injection pump, the fuel injection pump and apparatus attached thereto being shown in a longitudinal side elevational view, partly in section and partly broken away;

Fig. 2 is an enlarged longitudinal view, partly in section and partly broken away of the timing control and adjacent portions of the fuel injection pump shown in Fig. 1;

Fig. 3 is an enlarged longitudinal view partly in section of the control valve shown in Fig. 1;

Fig. 4 is an enlarged longitudinal view partly in section of a modification of the control valve shown in Fig. 3; and

Fig. 5 is an enlarged longitudinal view partly in section of another modification of the control valve shown in Fig. 3.

Referring now to the drawings in detail, the apparatus of the present invention is shown in association with a fuel injection pump 10 of the type shown and claimed in U.S. patent No. 3 704 963 granted December 5, 1972 and assigned to the assignee of the present invention. The pump 10 is provided with a housing 12 having a sealed cover 14 secured thereto by screws 16. A drive shaft 18 adapted to be driven by an associated engine (not shown) is journaled in the housing 12 and is connected to and drives a fuel distributing rotor 20.

Connected to the outer end of rotor 20 is a vane-type low pressure transfer or supply pump 22 which receives fuel from a fuel supply tank or reservoir 24 connected by conduit 26 to a fuel inlet 27 in the headplate 28 and delivers the fuel under pressure via axial passageway 30, annulus 32 and passage 34 to metering valve 36. A pressure regulating valve 38 regulates the outlet pressure of the transfer pump 22 and returns excess fuel to the fuel inlet 27. The operation of the regulating valve 38 is such that the transfer pump output pressure increases in relationship to engine speed. A typical transfer pump regulated in this manner may, for example, produce a pump pressure of about 3 bar at 1200 rpm increasing to around 6 bar 3200 rpm.

Plungers 40 mounted in the diametral bore 42 of the rotor 20 form a high pressure charge pump which receives metered inlet fuel from the metering valve 36 via diagonal passageway 44 which registers sequentially with spaced apart radial ports 46 (two shown) as the rotor 20 is rotated, and which delivers charges of fuel at high pressure via axial bore 48 to a radial passage 50 which registers sequentially with angularly spaced outlet passages 52 (one shown) which communicate with the engine fuel injection nozzles (not shown). A valve 54 disposed in the axial bore 48 is utilized to provide sharp cut-off of fuel to the nozzles at the end of the pumping strokes.

The pumping action of the plungers 40 is achieved by means of an annular cam 56 having diametrically opposed camming lobes 58 which are engaged sequentially by rollers 60 carried by shoes 62 when the rotor is rotated. The rollers 60 and shoes 62 are mounted in the rotor 20 in alignment with the plungers 40 for engagement with the outer ends thereof whereby the plungers 40 are cammed inwardly to produce a pumping stroke each time the rollers engage a pair of opposite lobes 58. The annular cam 56 is mounted so that it can be angularly adjusted whereby the timing of the pumping strokes of the plungers 40 can be adjusted to occur slightly sooner (advanced) or slightly later (retarded) as the drive shaft 18 is rotated. The radially extending connector pin 64 provides means for rotatably shifting the cam 56 to adjust the timing.

In order to adjust the timing of the pumping strokes of the plungers 40 automatically in relationship to the speed of an associated engine, a cylinder 66 is provided in the housing 12 extending tangentially to and in the same plane as the annular cam 56. The right hand end of the cylinder 66 as viewed in Fig. 2 communicates via passage 68 with the axial output passageway 30 of the transfer pump, and the opposite end is vented through opening 70 to the interior of the housing 12. Slidably mounted in the cylinder 66 is a piston 72 which is connected to the connecting pin 64. A spring 74 seated at its outer end on an adjusting screw 75 urges the piston 72 to the right as viewed in Fig. 2.

As will be apparent, when engine speed increases the fluid pressure applied to the right hand end of the piston 72 by the output of the transfer pump 22 will increase and drive the piston to the left as viewed in Fig. 2 which will angularly adjust the cam 56 in a direction to advance the timing of the pumping strokes of the plungers 40 and when engine speed decreases, the pressure on the right hand end of the piston will drop due to the lower fluid pressure output of the transfer pump 22 and the leakage of fuel through bleed orifice 69 enables the spring 74 to drive the piston 72 in the reverse direction thereby turning the cam 56 in a direction to retard the timing of the pumping strokes. This type of automatic timing means is well known and is commonly used in connection with fuel injection pumps of the type to which the present invention pertains.

The housing 12 has a vent opening 76 located at a part of the housing which is uppermost when the pump 10 is installed on an engine. Normally this opening is controlled by a normally closed

pressure valve adapted to maintain a fluid pressure in the housing of about 0.55 to 0.7 bar and which will open and return excess fuel via fuel line 78 to the fuel tank 24 when pressure exceeds this amount. Since this pressure is also maintained in the vented of cylinder 66 because it is in communication with the interior of the housing at opening 70, this housing pressure assists the spring 74 in urging the piston 72 to the right as viewed in Fig. 2 in the direction for retarding the timing of the pumping strokes.

In accordance with this invention, means are provided for temporarily releasing or dumping the fluid pressure existing in the housing 12 to effect an advancement in timing under selected engine operation conditions, such as, for example, during cold starting and idling of the associated engine. As a specific example, it has been found that by dumping the housing pressure from 0.55 bar to 0 bar, the cam 56 can be angularly shifted by as much as 2° which, because the pump is rotated at one-half engine speed, represents a timing advance of 4° which is ample for the intended purpose.

While various means could be utilized for temporarily releasing the fluid pressure from the housing 12, have shown in Figs. 3 - 5 of the drawings, embodiments of a valve 81 which illustrates a preferred mode of carrying out the objects of the invention. These valves are intended to replace the conventional pressure valve normally connected to the vent opening 76 of the housing at a fixed housing pressure. These embodiments have in common a valve body 80 adapted to be connected to the threaded vent opening 76 and an internal passageway 84 normally closed by a ball 86 urged against a seat 88 by a spring 90 and having an outlet 92 for connection to the fuel line 78 which returns released fuel to the fuel tank 24.

In the embodiment shown in Fig. 3, the valve may be temporarily opened to vent the fluid pressure from the housing by energizing a solenoid 94 having a plunger 96 extending into the passageway 84 and adapted to engage and unseat the ball 86 when the solenoid is energized.

In the embodiment shown in Fig. 4, the spring 90 the ball 86 against the seat 88 is seated at its outer end against spring seat 99 provided at the end of plunger 100 of a solenoid 102. When the solenoid 102 is energized, the plunger 100 is withdrawn until the spring seat bottoms against the end of the solenoid to release the bias of spring 90 on ball 86 to allow the ball to become unseated.

In the embodiment shown in Fig. 5, the valve body 80 is provided with a by-pass passageway 104 which is normally closed by the plunger 106 of the solenoid 108. When the solenoid 108 is energized, the plunger 106 is withdrawn permitting the fluid pressure to escape via passageway 104 around the seated ball 86.

As will be apparent, the solenoids of the valves 81 can be operated by any suitable control means depending upon the conditions under which temporary advancement of the timing is desired. In the simplest embodiment, the control means could be a manually operated switch but for automatic operation such as in response to engine temperature the solenoid could preferably be operated, for example, by a control circuit which senses the coolant temperature of the engine. Another example of suitable control means could be a mechanical device responsive to the position of the engine throttle lever 77 to unseat ball 86 (Fig. 3) or actuate plunger 106 (Fig. 5). An inherent advantage of utilizing the solenoid release function of the specific embodiments described above is that they operate in a fail-safe manner in that if the solenoid fails to function, the normal pressure will be maintained in the housing 12 and control of the timing in response to engine speed will not be interfered with.

Claims

1. Fuel injection pump having a housing (12), said housing (12) having a drainage passageway (78) connected thereto and pressure relief valve means (81) in said drainage passageway (78) for normally maintaining a predetermined gegenerally constant pressure in said pump housing (12), an inlet metering valve (36) a rotary charge pump having radially extending pumping plungers (40) adapted to be actuated inwardly by a cam ring (56) to deliver measured charges of liquid fuel in successive pumping strokes to the cylinders of an associated engine, timing means to vary the timing of the pumping strokes relative to the operation of the associated engine, and actuating means for actuating the timing means for advancing and retarding the timing of the pumping strokes in response to the operating conditions of the associated engine, said actuating means comprising a piston (72) for actuating the timing means and having its ends exposed to fluid chambers at the opposite ends thereof, spring means (74) engaging one end of the piston and said predetermined generally constant pump housing pressure in communication with one chamber at said one end of the piston biasing the piston in the direction to retard the timing, a source of fluid under pressure correlated with engine speed in communication with the other chamber at the other end of the piston (72) and acting against the bias of the spring (74) and fluid pressure in said one chamber to advance the timing with increased engine speed, characterized by pressure dump means selectively operable during cold starting or cold idling of the associated engine to connect said pump housing (12) to drain for dunning the fluid pressure from said pump housing and in said one chamber to the exterior of said pump housing (12) and thereby advancing the timing by a predetermined amount.

2. Fuel injection pump according to claim 1, characterized in that the force of the spring

means (74) biasing said piston (72) in the retard direction is adjustable to adjust the responsiveness of the piston (72) to fluid pressure.

3. Fuel injection pump according to claim 1, characterized in that the source of fluid under pressure correlated with engine speed is transfer pump (22).

4. Fuel injection pump according to any one of claims 1 to 3, characterized in that the pressure dump means is means for opening the valve means (81).

5. Fuel injection pump according to any one of claims 1 to 3, characterized in that the pressure dump means is means bypassing the valve means (81).

6. Fuel injection pump according to any one of claims 1 to 3, characterized in that the valve means (81) is a one-way ball valve and the pressure dump means is means for unseating the ball.

7. Fuel injection pump according to any one of claims 1 to 3, characterized in that the valve means (81) comprises a one-way ball valve and associated spring means (90) urging the ball (86) into seated position, and the pressure dump means is means for releasing the pressure of the associated spring means (90).

8. Fuel injection pump according to any one of claims 1 to 7, characterized in that the pressure dump means is solenoid operated.

9. Fuel injection pump according to claim 8, characterized in that the solenoid (94; 102; 108) is energized responsive to the temperature of the associated engine.

10. Fuel injection pump according to claim 8, characterized in that the solenoid (94; 102; 108) is manually energized.

Patentansprüche

1. Kraftstoffeinspritzpumpe mit einem Gehäuse (12), wobei das Gehäuse (12) mit einem Entleerungskanal (78) versehen ist, der an das Gehäuse (12) angeschlossen ist und in welchem ein Druckminderventil (81) vorgesehen ist, um normalerweise den Druck in dem Gehäuse (12) der Pump auf einem vorbestimmten, im wesentlichen konstanten Wert zu halten, mit einem Einlassdosierventil (36), einer Rotationsladepumpe mit radial angeordneten Pumpenkolben (40) welche über einen Nockenring (56) nach innen zu drängen sind, zum Zuführen von dosierten Ladungen von Flüssigkraftstoff durch aufeinanderfolgende Pumphube zu den Zylindern eines zugeordneten Motors, einer Spritzund Verstellvorrichtung zur Veränderung der zeitlichen Einstellung der Pumphube in bezug auf den Betrieb des zugeordneten Motors, und einer Vorrichtung zur Betätigung der Spritzund Verstellvorrichtung zur zeitlichen Vor- und Rückstellung der Pumphube in Abhängigkeit der Betriebsbedingungen des zugeordneten Motors, wobei die Betätigungsvorrichtung einen Kolben (72) umfasst zur Betätigung der Spritz- und Verstellvorrichtung, welcher Kolben mit seinen Enden Fluidkammern an gegenüberliegenden Enden des Kolbens ausgesetzt ist, wobei eine an einem Ende des Kolbens angreifende Feder (74) und der mit einer Kammer an dem besagten einen Ende des Kolbens in Verbindung stehende vorbestimmte, im wesentlichen konstante Druck des Pumpengehäuses den Kolben in Richtung zur Rückstellung des Spritzpunktes drücken, und wobei eine Fluidquelle unter motordrehzahlabhängigem Druck mit der anderen Kammer an dem anderen Ende des Kolbens (72) in Verbindung steht und gegen die Kraft der Feder (74) und den Fluiddruck in der besagten einen Kammer wirkt, um den Spritzpunkt bei zunehmender Motordrehzahl vorzustellen, gekennzeichnet durch eine bei Kaltstart oder bei Kaltleerlauf des zugeordneten Motors wahlweise zu betätigende Druckablassvorrichtung, um das Pumpgehäuse (12) an die Ablassleitung (78) anzuschliessen zwecks Entspannen des Fluiddrucks in dem Pumpengehäuse und in der besagten einen Kammer nach aussen aus dem Pumpengehäuse (12), um somit den Spritzpunkt um einen vorbestimmten Wert vorzustellen.

2. Kraftstoffeinspritzpumpe nach Anspruch 1, dadurch gekennzeichnet, dass die Kraft der Feder (74) welche Kolben (72) in Richtung zur Rückstellung des Spritzpunktes belastet, einstellbar ist, um die Ansprechempfindlichkeit des Kolbens (72) an den Fluiddruck einzustellen.

3. Kraftstoffeinspritzpumpe nach Anspruch 1, dadurch gekennzeichnet, dass die Fluidquelle unter motordrehzahlabhängigem Druck eine Förderpumpe (22) ist.

4. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass die Druckablassvorrichtung eine Vorrichtung zum öffnen des Ventiles (81) ist.

5. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 3, durch gekennzeichnet, dass die Druckablassvorrichtung eine Vorrichtung zum Umgehen des Ventiles (81) ist.

6. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass das Ventil (81) ein Einwegkugelventil ist und die Druckablassvorrichtung eine Vorrichtung ist, um die Ventilkugel von ihrem Sitz abzuheben.

7. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass das Ventil (81) ein Einwegkugelventil sowie eine zugeordnete Feder (90) umfasst, welche die Kugel (86) gegen ihren Sitz drückt, und dass die Druckablassvorrichtung eine Vorrichtung zum Entspannen der zugeordneten Feder (90) ist.

8. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass die Druckablassvorrichtung durch eine Magnetspule zu betätigen ist.

9. Kraftstoffeinspritzpumpe nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, dass die Magnetspule (94, 102, 108) in Abhängigkeit der Temperatur des zugeordneten Motors zu erregen ist.

10. Kraftstoffeinspritzpumpe nach Anspruch 8, dadurch gekennzeichnet, dass die Magnetspule (94, 102, 108) von Hand zu betätigen ist.

Revendications

1. Pompe d'injection de carburant comportant un logement (12), ce logement (12) comportant un passage de purge (78) rélié au logement et une soupape de surpression (81) située dans le passage de purge (78) pour maintenir normalement une pression prédéterminée généralement constante dans ledit logement (12) de la pompe, une soupape de dosage d'entrée (36), une pompe de charge rotative ayant des plongeurs de pompage (40) s'étendant radialement, destiné à être commandé vers l'intérieur par une bague à cames (56) pour distribuer des charges mesurées de carburant liquide par courses de pompage successives aux cylindres d'un moteur associé, un moyen de réglage destiné à faire varier le moment des courses de pompage par rapport au fonctionnement du moteur associé, ainsi qu'un moyen de commande pour actionner le moyen de réglage pour avancer et retarder le moment des courses de pompage en réponse aux conditions de fonctionnement du moteur associé, ce moyen de commande comportant un piston (72) destiné à actionner le moyen de réglage et ayant ses extrémités exposées à des chambres de fluide aux extrémités opposées à ce dernier, un ressort (74) venant s'engager sur une extrémité du piston et ladite pression prédéterminée généralement constante du logement de la pompe en communication avec une chambre à l'extrémité précitée du piston poussant le piston dans la direction pour retarder le moment des courses de pompage, une source de fluide sous pression en corrélation avec la vitesse du moteur en communication avec l'autre chambre à l'autre extrémité du piston (72) agissant à l'encontre de la poussée du ressort (74) et de la pression de fluide dans la chambre mentionnée en premier lieu afin d'avancer le moment des courses de pompage dans le cas d'une augmentation de la vitesse du moteur, caractérisée par un moyen de décharge de pression pouvant être actionné sélectivement lorsque le moteur est mis en marche à l'état froid ou lorsqu'il tourne à faible vitesse à l'état froid pour relier le logement (12) de la pompe à la voie d'écoulement pour décharger la pression de fluide du logement de la pompe et de ladite chambre citée en premier lieu vers l'extérieur du logement (12) de la pompe et assurer ainsi une avance prédéterminée des courses de pompage.

2. Pompe d'injection de carburant suivant la revendication 1, caractérisée en ce que la force du ressort (74) poussant le piston (72) dans la direction pour retarder le moment des courses de pompage est ajustable afin de régler la sensibilité du piston (72) à la pression de fluide.

3. Pompe d'injection de carburant suivant la revendication 1, caractérisée en ce que la source de carburant sous une pression en corrélation avec la vitesse du moteur est une pompe de transfert (22).

4. Pompe d'injection de carburant suivant l'une quelconque des revendications 1 à 3, caractérisée en ce que le moyen de décharge de pression est un moyen destiné à ouvrir la soupape (81).

5. Pompe d'injection de carburant suivant l'une quelconque des revendications 1 à 3, caractérisée en ce que le moyen de décharge de pression est un moyen mettant la soupape (81) en dérivation.

6. Pompe d'injection de carburant suivant l'une quelconque des revendications 1 à 3, caractérisée en ce que la soupape (81) est une soupape sphérique à une voie, tandis que moyen de décharge de pression est un moyen destiné à déplacer la bille de cette soupape à l'écart de son siège.

7. Pompe d'injection de carburant suivant l'une quelconque des revendications 1 à 3, caractérisée en ce que la soupape (81) comprend une soupape sphérique à une voie et un ressort associé (90) poussant la bille (86) de cette soupape sur son siège, tandis que le moyen de décharge de pression est un moyen destiné à détendre la pression exercée ressort (90).

8. Pompe d'injection de carburant suivant l'une quelconque des revendications 1 à 7, caractérisée en ce que le moyen de décharge de pression est actionné par un solénoïde.

9. Pompe d'injection de carburant suivant la revendication 8, caractérisée en ce que le solénoïde (94; 102; 108) est excité en réponse à la température du moteur associé.

10. Pompe d'injection de carburant suivant la revendication 8, caractérisée en ce que le solénoïde (94; 102; 108) est excité manuellement.

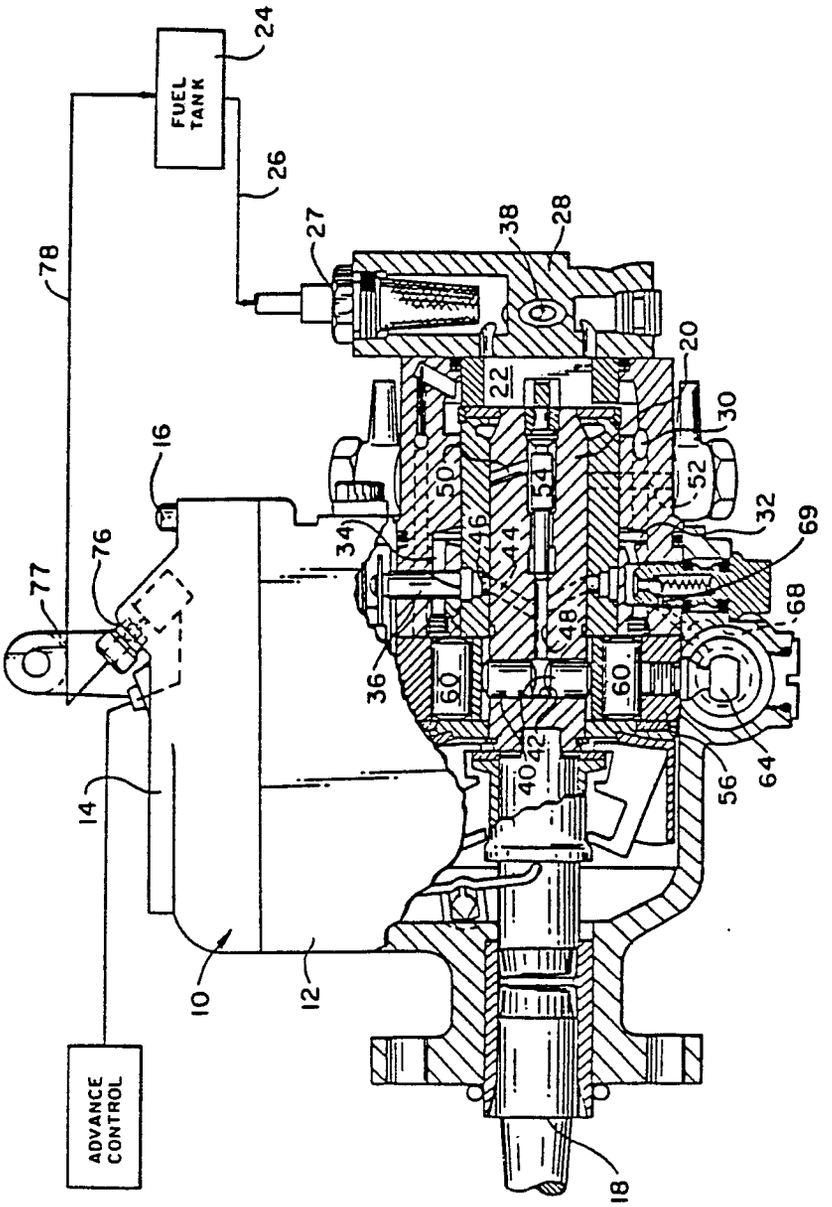

FUEL TANK
ADVANCE CONTROL
24
26
27
28
38
78
20
22
30
16
50
54
52
32
69
34
46
44
77
76
68
48
36
60
60
42
40
14
56
64
10
12
18

FIG. 1

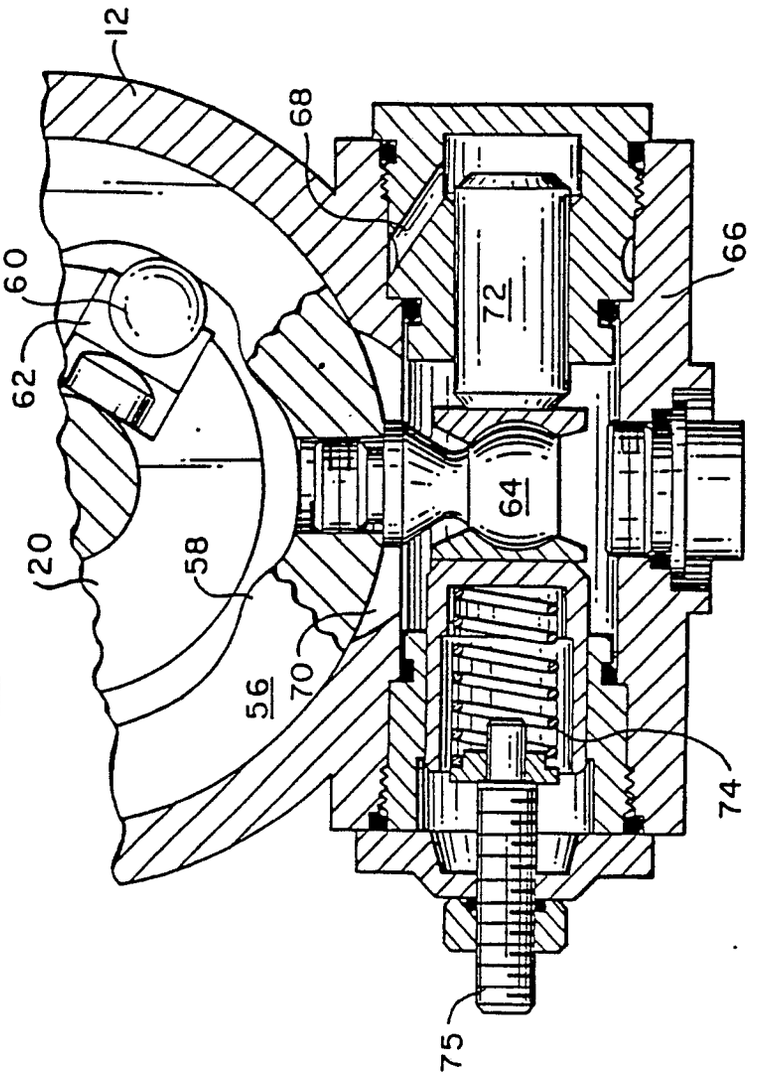
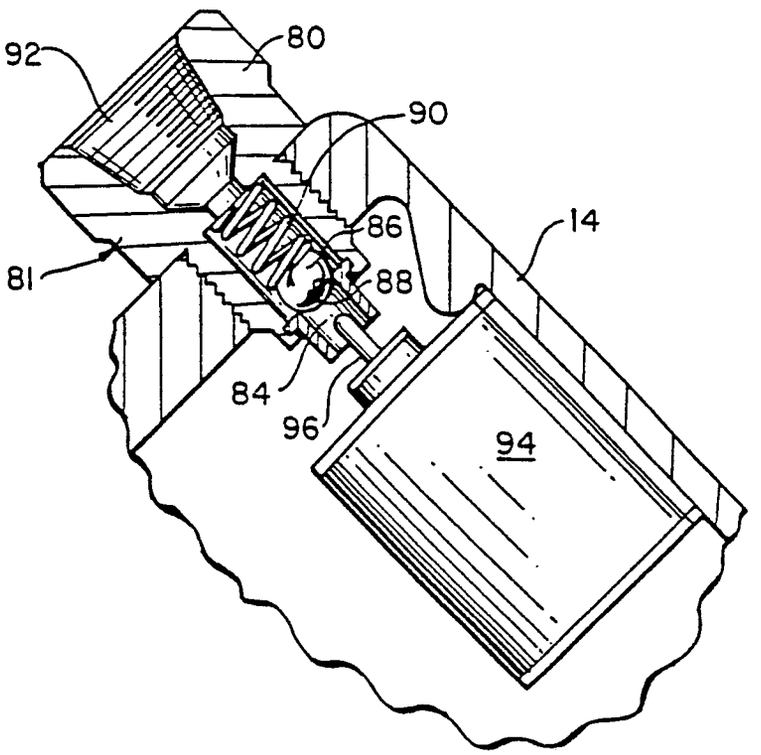


FIG. 2

FIG 3



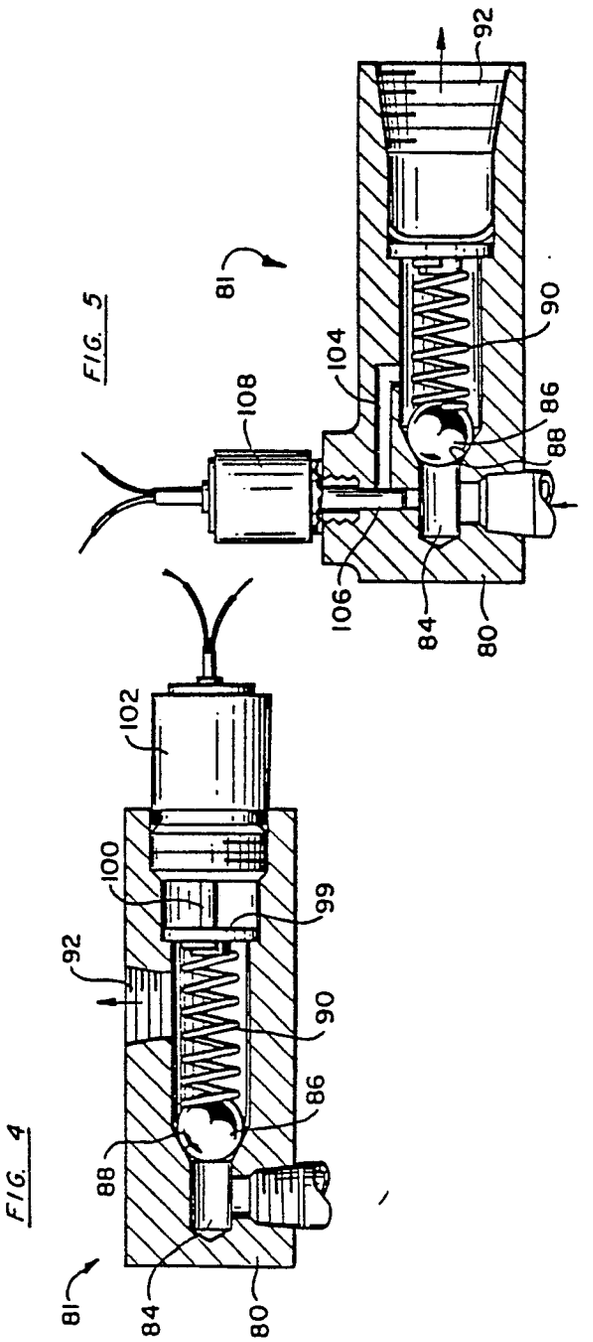


FIG. 5

FIG. 4